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GRINDING PEBBLES AND TUBE-MILL LINERS

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BY

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

GRINDING PEBBLES AND TUBE-MILL LINERS[1/]

By Robert W. Metcalf[2/]

Since the spread of the European war virtually cut off imports from Denmark, Belgium, and France, the Bureau of Mines has had numerous inquiries as to domestic sources of grinding pebbles and silex or other types of ball-mill liners.

USES

Flint pebbles and tube-mill liners are used by grinders of certain ceramic materials to prevent contamination of the finished product by iron abraded from steel balls and liners. The feldspar industry is one of the largest users of flint grinding mediums; they are employed also by certain grinders of talc and soapstone, ground sand and sandstone, quartz, and chalk. Some paint materials, such as lithopone, have been ground in pebble mills. Flint pebbles have been used more or less in the past, especially by cement manufacturers and, for fine grinding of gold, copper, or other ores in which iron contamination is not especially deleterious.

IMPORTS

Grinding pebbles have been imported from France and Denmark and silex liners from Belgium. It is impossible to state the exact tonnages of grinding pebbles and liners imported, as other pebbles and flints of various sizes and shapes intended to be ground for use in ceramic bodies are included in the customs classification of "flint, flints, and flintstones". For some years before 1930, pyrophoric alloy "flints" for pocket lighters and gas lighters likewise were included. During the past 15 or 20 years, however, imports under this more general classification have ranged from 26,636 short tons in 1920 to 3,754 tons in 1932, and for 1922 to 1929, inclusive, they ranged from 14,000 to 17,000 tons. After the 1932 low, imports increased gradually to 13,428 tons in 1937 and were 11,987 tons in 1939. Since the first quarter of 1940, imports undoubtedly have been greatly curtailed and perhaps have been nonexistent.

Only two firms, one Danish and one French, have supplied foreign pebbles to American consumers. The pebbles occur in distinct beds in the white chalk cliffs of the islands of Zealand, Möen, and Langeland on the Danish coast, and on the French coast, largely between Havre and Dieppe. They are gathered

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2/ Nonmetal Economics Division, Bureau of Mines.

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by hand along the beach, washed with water in large rotating drums, then run over a picking belt where "fine-quality blue nodule" flint and "prime-quality hard" flint pebbles are picked out separately, leaving second-quality flint and granite for construction work or waste. In France, crude pieces of flint of any size or shape and the less-tough pebbles also are gathered and exported for use as crushed flint in potteries. Although no universal standard for grading flint pebbles is recognized, the following classification of Danish pebbles into seven grades according to size has been used by one importer:

Size No.	Diameter (inches)	Size No.	Diameter (inches)
1	1 to 1 3/4	5	4 1/2 to 5 1/2
2	1 3/4 to 2 3/8	6	5 1/2 to 6 3/4
3	2 3/8 to 3 1/4	7	6 3/4 to 7 7/8
4	3 1/8 to 4 1/2		

An analysis of French flint pebbles gathered near Dieppe follows:

Silica.....	98.20	Magnesia.....	0.10
Alumina.....	.30	Loss on ignition...	1.00
Chalk.....	.40		100.00
		Specific gravity...	2.76

Germany and the United States have been the two leading markets for Danish pebbles, accounting for 60 percent of the total exports in recent years. Other markets included Norway, Sweden, Australia, Brazil, and Japan.

Belgian silex lining was quarried like building stone, and the larger pieces were rough-cut or shaped by hand chisels and hammers somewhat like large granite paving blocks. According to a recent informant, the sizes formerly supplied from Belgium were 2, 2 1/2, 3, and 4 inches thick; usually between 4 and 5 inches wide; and from 6 to 9 inches long.

DOMESTIC PRODUCTION

For several years the only commercial production of grinding pebbles and tube-mill liners known to the Bureau of Mines has been that of the Jasper Stone Co., Sioux City, Iowa. This firm has marketed mill liners and artificially rounded pebbles from its quartzite deposits near Jasper, Rock County, Minn., for a long time. In the past it produced cut cubes, mill liners, and pebbles from the Sioux quartzite in Iowa and near East Sioux Falls, Minnehaha County, S. Dak., but no production from these localities has been reported for 10 to 15 years.

Before 1936 a steady output of beach pebbles from the shore line between Oceanside and Encinitas, San Diego County, Calif., was reported. These pebbles, largely fine-grained tuffs, porphyry, and granite, were washed up

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on the beaches after severe storms, entangled in seaweed torn loose from the ocean floor. They ranged from 2 to 7 inches in diameter; were smooth, round, or nearly round; and were picked by hand from the beaches, sorted roughly according to size, and used chiefly in grinding cement. Although tough and said to be harder to break than Danish flint pebbles, the California pebbles wore somewhat faster on hard material, being coarser-grained and less smooth than the Danish pebbles. On very hard ore they were considered to be about half as efficient and required a larger charge; however they cost less than half as much.

Various types of selected, well-rounded stream or beach pebbles of rhyolite, basalt, granite, or other hard, tough rock have been used locally, particularly in the Rocky Mountain region and in the Pacific Coast States. Dense, banded rhyolite blocks rounded by tumbling formerly were obtained near Manhattan, Nev., and used in metallurgical mills. Granite pebbles found in the Sierra Nevada Mountains are used by some gold mills. Chunks of flinty ore and tough blocks of trap rock have been utilized as grinding mediums for tube mills. The United States Reclamation Service used angular blocks of basalt rock in its cement mill during the construction of the Arrowrock Dam; the corners and edges were quickly ground off, and after the blocks were reduced to spherical or ellipsoidal forms, the material was said to wear better and longer than Danish pebbles.

POSSIBLE DOMESTIC SOURCES

Pebbles of granite, quartzite, and other stone have been imported from the Canadian shore of Lake Superior and from Conception Bay, Newfoundland, for use in cement mills. Rhyolite and felsite pebbles are abundant along the New England seashore from Marblehead, Mass., to Eastport, Maine. Some of these pebbles are quite tough, but samples have been rejected for feldspar grinding because of the iron content. In the Gulf States and in the Southern Appalachian and Ozark Mountain regions at the edge of the Coastal Plain are numerous deposits of flint pebbles, most of which do not exceed 2 1/2 inches in diameter, along stream terraces and bottoms. The Cretaceous limestones in central Texas, particularly the Edwards limestones, are flint bearing. Other tough pebbles of siliceous materials, such as agate, carnelian, or petrified wood, found in abundance in certain parts of the country, might be suitable as grinding mediums. Extensive deposits containing pebbles of novaculite, a very hard and dense siliceous rock in Pike, Howard, and Sevier Counties, Ark., have been described by the Geological Survey.3/

Tube-mill liners and possibly artificially rounded grinding pebbles formerly were supplied from the Ocala limestone beds in Florida and from the Ft. Payne chert near Iron City, Tenn.4/ Mill liners and artificially rounded

3/ Miser, H. D., and Purdue, A. H., Gravel Deposits of Caddo Gap and DeQueen Quadrangles, Ark.: Geol. Survey Bull. 690, 1919, pp. 15-30; Geology of the DeQueen and Caddo-Gap Quadrangles, Ark.: Geol. Survey Bull. 808, 1929, 195 pp.

4/ Miser, Hugh D., Mineral Resources of the Waynesboro Quadrangle, Tennessee: Tennessee State Geol. Survey, Bull. 26, Nashville, Tenn., 1921, pp. 132-135.

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pebbles also might be obtained from one of the quartzite belts of central and southeastern Pennsylvania or from the ganister or quartzite rock of Calhoun, Talladega, Cherokee, Clay, and Cleburne Counties, in Alabama.

Recently the Bureau of Mines has been informed that the United Feldspar & Minerals Corporation, Minpro Division, Spruce Pine, N. C., has experimented with quartzite from its Deer Park property and with topaz for both mill liners and grinding pebbles with highly satisfactory results. Quartz fragments used for making potters' flint are withdrawn from the mills as soon as they have become sufficiently rounded and then used as pebbles in the feldspar grinding mills.

Information as to undeveloped deposits in various States usually can be obtained from the respective State geologists. The following firms have indicated that they may be able to supply quartz pebbles or liner blocks:

Dealers, importers, and suppliers of grinding pebbles and silex liners

California:
Atkins, Kroll & Co., 200 California St., San Francisco.
King Solomon Gold Mines, Black Bear (or Crocker Bldg., San Francisco).
John C. Monand, Carlsbad.

Delaware:
E. I. Du Pont de Nemours & Co., Inc., R. & H. Chemicals Dept., Dupont Bldg., Wilmington, Del.

Iowa:
Jasper Stone Co., Sioux City, Iowa.

Maryland:
Clinchfield Sand & Feldspar Corporation, Hearst Tower Bldg., Baltimore.

New Jersey:
Paul O. Abbe, Inc., 130 Center Ave., Little Falls.
Eureka Flint & Spar Co., Trenton.

New York:
Abbe Engineering Co., 54 Church St., New York.
J. R. Alsing Engineering Co., 50 Church St., New York.
Buedendorf Bros., 2 Broadway, New York.
John W. Higman Co., 24 State St., New York.
New Jersey Pulverizing Co., 205 West 34th St., New York.
F. L. Smidth & Co., 225 Broadway, New York.
Taintor Trading Co., Inc., 21 State St., New York.
B. Voigt, 250 W. 57th St., New York.

North Carolina:
United Feldspar & Minerals Corporation, Minpro Division, Spruce Pine.

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Ohio:
Patterson Foundry & Machine Co., East Liverpool.

Pennsylvania:
Philadelphia Steel & Iron Co., Washington Ave., Conshohocken.
Traylor Engineering & Mfg. Co., 666 South 10th St., Allentown.
Charles A. Wagner Co., Inc., 811 Callowhill St., Philadelphia.

Tennessee:
J. Howard Swaim, 916 Cotton States Bldg., Nashville.

Wisconsin:
Manitowoc Engineering Works, Manitowoc.

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